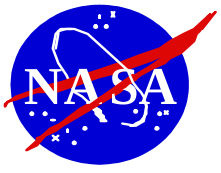
Suborbital and Special Orbital Projects Directorate
803/Safety Office

Working in Tropical Weather Environments

Guidelines and Recommendations

July 20, 2004



National Aeronautics and Space Administration

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Check the 803 Homepage at
http://www.wff.nasa.gov/~code803/restricted/processes.html
to verify that this is the correct version prior to use

FOREWORD

This document establishes the recommendations and guidelines for effectively working in tropical weather environments while supporting the Suborbital and Special Orbital Projects Directorate missions.

Comments and questions concerning the contents of this document should be addressed to the Safety Office; Code 803; E-107; Wallops Flight Facility; Wallops Island, VA 23337. This is a controlled document and will be reviewed annually and revised by page changes when necessary.

AVAILABILITY

Copies of this plan will be distributed to applicable WFF personnel prior to them performing work in a tropical weather environment. This document is posted at http://www.wff.nasa.gov/~code803/pages/WTWE2004.html Additional copies may be obtained from the WFF Safety Office, Code 803.

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Requirements, Guidelines, and Recommendations for Working in Tropical Weather Environments

1. Purpose

NASA personnel and support contractor employees are frequently called upon to work at locations in tropical environments. Some of these areas include, but are not limited to, Kwajalein Atoll, Australia, and Brazil. Due to the nature of the activities pursued by Code 800, guidelines are necessary to ensure personnel safety and to maintain the quality of on-the-job performance. This guideline has been developed to define tropical weather recommendations and to inform employees supporting Code 800 operations.

2. Applicable

This guideline is applicable to all operations managed by or under the auspices of Code 800. This guideline is also applicable to support contractors and other directorates when their work duties are to support Code 800 missions. When not supporting Code 800 missions, support contractors having their own Safety and Quality Management System shall use their own policies and guidelines for all efforts within their own facilities.

3. Requirements

All personnel shall be briefed by the Safety Office and the WFF Health Unit Staff prior to performing work in a tropical weather environment.

For travel to foreign destinations, a medical evaluation shall be required. Each worker shall be evaluated by the NASA occupational medicine physician, or alternatively by his/her private physician at their own expense. The medical evaluation should be scheduled by the employee immediately upon receiving notification of the assignment to assure effective administration of any necessary immunizations and/or adjustment of medication regimens. The WFF Health Unit at the time of the evaluation will also provide information on destination specific health concerns (e.g. unsanitary drinking water). In accordance with NPR 1810.1, Health Services for International Travel, the WFF Health Unit will complete a medical clearance certification form and send it on to the Code 800 Foreign Travel Coordinator (Ms. Lisa Bass).

Outside work shall be discontinued when the estimated Wet Bulb Globe Temperature (WBGT) exceeds 105.4°F (40.8°C). See Table 7.1A for guidance on how to estimate the WBGT.

4. General Information

A person's ability to perform effectively in hot, humid conditions depends on both his/her acclimatization and level of fitness. The degree of heat stress directly depends on the relative workload. When two people do the same task, the heat stress is less for the person

who is in better physical condition and his/her performance is likely to be better. Therefore, it is important to maintain high levels of fitness. If an employee who has been designated for assignment to a tropical work site does not maintain an ongoing, vigorous personal exercise routine, he/she should consult his/her private physician or a NASA occupational health physician at his/her primary NASA facility as soon as possible upon notification of the intended assignment and begin an appropriate physical conditioning regimen.

As many chronic medical problems and various medications, both prescription and non-prescription, impact on an individual's tolerance of and acclimatization to tropical conditions, each worker should be evaluated by his/her private physician or by the NASA occupational medicine physician. The medical evaluation should be scheduled by the employee immediately upon receiving notification of the assignment to assure effective administration of any necessary immunizations and/or adjustment of medication regimens in a timely manner.

5. Definitions

a. Acclimatization – The processes by which an individual accommodates to excessive environmental temperature, which include a lowered core temperature threshold for initiation of sweating and dilatation of peripheral blood vessels to increase dissipation of heat from skin surfaces. Acclimatization requires 7–14 days of exposure.

b. Cataract – Opacification of the normally clear and transparent crystalline lens of the eye. While cataract formation is related to a myriad of medical disorders, repeated exposures to ultraviolet radiation over a prolonged period of time can speed the development of a cataract.

c. Dehydration –commonly refers to combined deficits in body water and sodium. More properly, dehydration refers to pure water depletion whereas volume depletion refers to combined deficits.

d. Dengue fever – An acute viral disease of short duration and rare severity, transmitted through the bite of *Aedes* mosquitoes. Except for a couple of extremely rare syndromes, complete recovery occurs.

e. Electrolyte abnormalities – The most clinically significant conditions involve abnormalities in concentrations of sodium, chloride and potassium ions in the blood. In a hot environment, electrolytes are lost in sweat and must be replenished along with appropriate amounts of water to maintain normal concentrations in blood. Significant deviations in electrolyte concentrations, both elevated and decreased, impact negatively on essentially all physiologic functions. Severe deviations in electrolyte concentrations can result in death from irreversible damage to vital organs, most notably the heart, brain and kidneys.

f. Heat Cramps - These occur in unacclimatized individuals who exercise vigorously in a hot environment, and are caused by electrolyte losses combined with hypotonic fluid intake. Most commonly involved are the larger muscle groups, especially in the lower extremities. The individual usually has a normal temperature and no symptoms other than the cramps.

g. Heat Exhaustion – Also known as heat prostration, this occurs in unacclimatized individuals who exercise vigorously in a hot environment while losing excess electrolytes and/or water. Such individuals usually have a normal or minimally increased temperature, but typically present with one or more of the following: headache, dizziness (often occurring with sudden postural changes), nausea/vomiting, muscular incardination, weakness, fatigue, irritability, mental confusion, thirst, profuse sweating and muscle cramps. The affected individual may experience heat syncope, or collapse, characterized by loss of consciousness (fainting), usually of sudden onset but brief duration.

h. Heat Stroke - This is a medical emergency that can lead to death. Heat stroke occurs due to a marked increase in body temperature when body thermal regulation is unable to dissipate heat adequately. Heat stroke is often precipitated in an unacclimatized individual engaged in a prolonged period of vigorous exercise in an environment of high temperature and humidity. Typically, the affected individual may be a laborer working outside in a hot, humid environment without access to adequate fluid replacement. However, individuals with inefficient temperature auto regulation - e.g., the elderly and those with chronic illnesses such as diabetes - can develop this condition at rest if confined for a prolonged period in an environment of high temperature and humidity with inadequate oral intake of water and electrolytes. An individual on diuretics or medications with ant cholinergic effects (e.g., antihistamines, many antidepressants, antispasmodics, et al.) is at greater risk for developing heat stroke. Core temperature may exceed 105 degrees Fahrenheit. The affected individual will usually present with altered mental status - confusion, delirium or coma.

i. Malaria – A parasitic disease of red blood cells caused by protozoa transmitted by the bite of *Anopheles* mosquitoes and characterized by irregular fevers and chills, as well as a spectrum of other nonspecific symptoms. Prompt treatment of acute malaria is usually curative, but certain forms may cause death despite aggressive treatment.

j. Sunburn – Damage to skin cells resulting from excessive exposure to ultraviolet radiation.

k. Yellow fever – An acute viral disease of short duration and extremely variable severity, transmitted through the bites of several species of mosquitoes. Many cases are mild or unapparent. Most clinically evident cases resolve with supportive treatment, but 5 to 10 percent of these may be fatal.

6. Training

There is no specific training readily available for working in a tropical environment. All personnel will be briefed by the Safety Office and WFF Health Unit Staff prior to performing work in a tropical weather environment.

7. Tropical Weather Injury Prevention

In tropical weather environments, temperatures sustained above 30^0C (86^0F) are commonplace and often are accompanied by high relative humidity. At these temperatures, the most likely injuries are heat cramps and heat exhaustion. Other potential injuries due to prolonged exposure to hot weather include sunburn, heat stroke, malignant hyperthermia and dehydration.

Tropical environments provide native habitats for many insect and arachnid species that are vectors for serious infectious and/or parasitic diseases such as malaria, yellow fever, dengue fever and others. Exposure of the skin to soil and fresh water ponds provides a route of entry for other infectious or parasitic diseases.

Tropical weather can change quickly. Storms with heavy rain can develop rapidly, with the attendant risk of flash flooding. High winds and lightning often occur with these storms, thus increasing the risk of serious injury to an unprotected individual.

Most tropical weather injuries and many infectious and parasitic illnesses affect people who are not properly prepared for the temperature, humidity, sun and other environmental exposures to which they are exposed. Appropriate dress is extremely important for prevention of most medical problems relating to tropical exposures. Personnel traveling to tropical climates should have proper dress; this includes work clothing that is comfortable but also gives sufficient protection to do the job safely. The minimum is lightweight and reflective (i.e., light-colored) clothing made of cotton, or cotton in combination with another material that does not inhibit transpiration of water, covering most of the body. In practice this includes a long-sleeve upper garment, a garment covering the lower body including the legs, footwear (safety boots or shoes, when appropriate), and a hat that protects the face, ears and neck from direct sunlight. To allow heat to escape, the hat should be ventilated where it covers the scalp.

7.1 Outside Operations

As a matter of practice, employees should not work alone or remote from their colleagues. Where it is not practical to avoid it, lone working should be sanctioned only after a thorough risk assessment has been carried out. Supervisory personnel must schedule periodic communications with a lone worker by personal contact, by telephone or by radio. In the event of a failure to establish contact or when the response to the contact suggests that the lone worker is experiencing physical or mental difficulty, the lone worker must be

removed immediately to a cool environment and appropriate medical attention must be provided.

Workers should constantly remain aware of the condition of their co-workers. If a co-worker appears overly fatigued, confused, clumsy or otherwise has difficulty with normal work functions, immediately remove the affected individual to a cool environment and obtain prompt medical consultation.

A. Heat-Related Illness (Heat Cramps, Heat Exhaustion, Heat Stroke)

During periods of excessive heat and humidity, work sessions should be scheduled during early morning and nighttime hours to avoid exposures to the hottest part of the day and the most direct sunlight. Supervisors should monitor hot environments by using a wet bulb thermometer (WBGT) criteria (see Table 7.1 A). During periods of excessive heat and humidity, employees should find shelter in air-conditioned or other relatively cooler environments.

When working in a hot, humid environment during windless conditions, motorized fans should be employed at the work site to direct a continuous flow of air past the workers. Increased airflow will increase the rate of evaporative heat loss when the relative humidity is <100%, and will facilitate increased convective heat loss at ambient temperatures below 92^0F (33^0C).

1) Blood electrolyte abnormalities must be avoided. Prior to beginning work, it is recommended that the worker drink at least 500 ml (approx. 16 oz.) of cool water or diluted fruit juice (e.g., lemonade or diluted orange juice). While working, it is recommended that the worker drink 250 ml (approx. 8 oz.) every 30 minutes. If ambient temperature exceeds 38^0C (100^0F), it is recommended that the worker drink at least 16 oz. of liquid, preferably an electrolyte replacement solution (such as Gatorade®, or others), every 30 minutes. Drinking only plain water to replace perspiration losses can result in serious, or even fatal, physiologic abnormalities due to dilution of electrolytes in the blood.

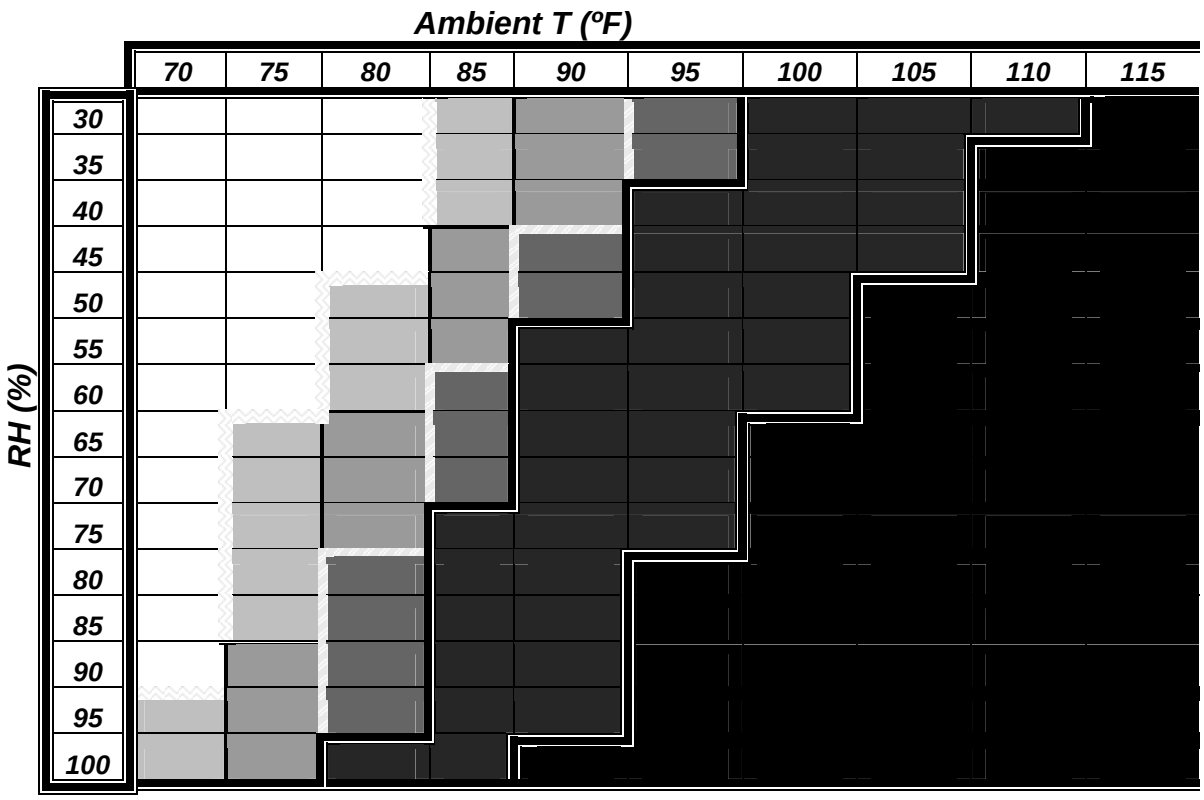
2) It is recommended that workers use salt liberally with food to maintain body sodium, also consume fresh fruits such as bananas and oranges daily to maintain body potassium. It is not recommended to take salt tablets, as the resulting large salt load can produce significant abnormalities in many major bodily functions.

3) It is recommended that workers restrict or discontinue the use of beverages containing alcohol and/or caffeine, as both of these substances increase urinary water loss. It is further recommended that no alcohol or caffeine be

ingested within four hours prior to any anticipated period of work in a hot environment.

4) Tobacco use is discouraged during periods of work in tropical environments. Use of tobacco products by any route (smoked or smokeless) constricts peripheral blood vessels and diminishes the efficiency of dissemination of excess body heat via evaporation and convection.

Estimated Wet Bulb Globe Temperature as a Function of
Ambient Temperature (T) and Relative Humidity (RH)



	<77.4 - Personnel may work continuously performing heavy work.
	77.4 – 85.1 - Personnel performing heavy work 50% of time & rest 50% of time
	82.2 – 85.6 - Personnel may perform heavy work 25% of time and rest 75% of time.
	86.1 – 89.8 - Personnel may perform light work 25% of time and rest 75% of time.
	90.7 – 105.4 - Personnel will exercise extreme caution: 1) no heavy outdoor work; and, 2) all outdoor work performed while under shade and with fans.
	>105.4 - No outdoor work.

Table 7.1 A

B. Sun Exposure (Ultraviolet Radiation)

It is recommended that sunscreen with a protection factor (SPF) of at least 30 will be applied liberally to all exposed skin. Sunscreen should be reapplied every 4 hours (or more frequently if excessive sweating is experienced as a result of physical exertion). Lightweight and light-colored outer clothing should be worn, preferably long-sleeved shirts and full-legged trousers. As lightweight cotton clothing does not provide complete protection from solar ultraviolet radiation, sunscreen also should be applied to any regions of skin covered by only a single layer of clothing. It is recommended that a cotton T-shirt be worn under a work shirt to provide increased sunburn protection. A head covering that shades the ears and back of the neck should also be worn to provide additional protection to these regions of skin that most frequently experience solar damage.

As cumulative exposure of the eyes to ultraviolet radiation is a major factor in the formation of cataracts, during daylight hours, regardless of cloud conditions, it is recommended that sunglasses be worn that provide protection from ultraviolet radiation. The sunglasses must be configured to provide "wrap-around" protection. Clip-on lenses attached to glasses do not provide adequate protection. Employees wearing corrective lenses should employ one of the following combinations: (1) contact lenses with appropriate sunglasses; (2) prescription sunglasses that provide correction of visual acuity deficits in addition to ultraviolet protection; or (3) ultraviolet-protecting sunglasses designed specifically to fit over and around standard corrective glasses.

7.2 Infectious Disease

As alterations in the integrity of the skin surface may become infected more readily in tropical environments, any cut or abrasion, no matter how minor, should be washed immediately and thoroughly with soap and clean water and the wound covered with a clean dressing. An injured worker should seek immediate medical attention for any wounds other than minor, superficial ones, especially for any puncture wounds and any wounds contaminated with dirt or soiled materials. It is recommended that an injured worker who has not had a tetanus immunization within 10 years contact the nearest medical facility within 24 hours of the injury to obtain a tetanus booster immunization.

When working where insect bites are likely, it is recommended that each worker apply insect repellant to the exposed skin. When applying sunscreen and insect repellant concurrently, the worker must first apply the sunscreen, allow it to be absorbed into the skin, and then apply the repellant. Additional and more complete protection is provided by wearing long sleeves and trousers and treating that clothing with an insecticide such as permethrin. Protection from insect bites is especially crucial at dawn and dusk when biting insects are the most active.

As many parasitic organisms resident in soil and water gain entry to the body through exposed skin, it is recommended that workers avoided walking barefoot on natural surfaces (bare ground, rock or grass), and not swim or wade in fresh water streams, ponds or lakes. If one inadvertently experiences such exposures, it is recommended that the exposed skin be washed immediately and thoroughly with soap and clean water.

In tropical environments uncooked and unprocessed foods may contain infectious agents, some of which may not be neutralized by washing or cooking. Processed and commercially packaged foods purchased at local grocery stores are probably safe for consumption but fresh, raw produce and raw meats may not be safe. Local fresh produce, seafood and meats purchased for consumption from street vendors, open-air markets or roadside stands should be avoided. Fruits, berries and vegetables should not be harvested from live plants for consumption. Fish or other seafood obtained recreationally from local waters should not be eaten.

7.3 Weather Disturbances

Lightning detection instrumentation will be deployed and monitored constantly during periods of outdoor work. In the absence of functioning lightning detection equipment, workers should remain alert for visible or audible evidence of lightning. If lightning is determined to be within six miles of an open workplace, workers must immediately seek the closest safe structure or location. The distance from lightning may be estimated by counting seconds between the lightning and the onset of the accompanying thunder; with 5 seconds corresponding to one mile. The safest structure is a building that is electrically grounded; generally, any building with plumbing or electrical wiring. While in shelter individuals should stay away from windows, and not use any corded electric equipment or telephone lines. If a grounded building is not in close proximity to the work site, a vehicle with a metal roof and closed windows can provide a safe refuge. Sheltered individuals should remain in the location of refuge for at least 30 minutes after the last observed lightning or thunder. When safe refuge is not available, employees will: avoid high ground, metal structures, electrical equipment and isolated trees or poles; avoid proximity to other people, allowing at least 15 feet between individuals; crouch low to the ground, with fee together, and ears covered by hands to prevent damage from loud thunder.

When heavy rainfall approaches or occurs, workers should be aware of the possibility of flash flooding. Areas that may be particularly prone to such flooding include any place where runoff water can be channeled into relatively narrow and confined locations such as gullies, streams or rivers with high banks, a confluence of such geographic features or any relatively low-lying area. If conditions exist where flash flooding may occur, workers should move immediately to elevations of relative safety. Under no circumstances should someone attempt to cross moving water, either on foot or in a vehicle.

When high winds are predicted or experienced, equipment and materials should be brought inside secure buildings and any objects remaining outside should be tied down or

otherwise secured to prevent injuries due to falling and flying objects. When high winds occur, workers should seek shelter inside a well-constructed building, remaining in an interior portion of the building away from any exterior windows or doors. Workers should not seek shelter inside lightly-constructed buildings such as metal or plywood sheds. Motor vehicles do not provide adequate safe shelter during high winds as they may be crushed by falling trees or other heavy objects, thus a motor vehicle should only be used for shelter when moving to better shelter may expose an individual to possible injury.

8. Resources

Other Sources of Information:

To learn more about heat-related illnesses go to:
http://www.wff.nasa.gov/~healthline/heat.htm

To learn more about how the body handles heat go to
http://www.wff.nasa.gov/~healthline/HStress.htm.

Handouts are also available in the Health Unit (Building F-160) waiting room.

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes